APPENDIX A - Contents of Silos 1 and 2

The estimated amount of silos residue is presented in Table A1. The Seller shall utilize these quantities to support the selection of recommended equipment for the full-scale treatment process.

The residue was slurried into the silos and then the free water was decanted off. The residue has a silty-clay, adhesive texture. Significant radioactive concentrations exist, but the radionuclides account for little of the bulk mass of the residue in the silos. The major radioactive constituents are uranium (<0.1 wt% in Silo 1 and 0.5 wt% in Silo 2), thorium (<0.1 wt% in Silo 1 and Silo 2), and radium (approximately 4500 grams total). Their impact on the chemistry of the silos residue is minimal. The chemistry of the silos residue shall be considered the same as the surrogate slurries provided in Tables C1 through C3 of Appendix C. Thermogravometric Analysis shows that the dry silos residue and the dry surrogate slurries lose approximately 15 wt% as the material temperature increases from room temperature to 1300 °C. The weight loss is fairly constant through this temperature range.

BentoGrout™ clay (a product of Cetco) was placed in the silos to form a cap over the residue to mitigate the escape of radon gas from the residue. The BentoGrout™ is now part of the Silos 1 and 2 waste stream. The elemental makeup (shown as oxides) of BentoGrout™ is shown in Table A2.

Table A1: Silo Residue Quantities

Material		Volume, m^3	Density In-Situ, g/cm^3	Density Dry, g/cm^3
Silo 1	Residue	3,282	1.73[1]	1.44[1]
	BentoGrout™	357	1.19	0.30
Silo 2	Residue	2,844	1.83[1]	1.28[1]
	BentoGrout™	314	1.19	0.30
Total		6,797	--	--

1 - Density values as reported in "Results of the Vitrification Treatability Study," R.A. Merrill and D.S. Janke, Battelle - Pacific Northwest Laboratory, February 1993.

Table A2: Average BentoGrout™ Composition

Rank	BentoGrout™		
	Component	Measured (wt%)	Normalized (wt%)
1	SiO_2	65.40	67.35
2	Al_2O_3	15.80	16.27
3	MgO	6.30	6.49
4	Fe_2O_3	3.60	3.71
5	Na_2O	3.40	3.50
6	CaO	1.80	1.85
7	K_2O	0.80	0.82
Total		97.10	100.00

APPENDIX B - Work Plan Outline

1.0 INTRODUCTION

- 1.1 PROJECT DESCRIPTION
- 1.2 TEST OBJECTIVES

2.0 TREATMENT TECHNOLOGY DESCRIPTION

3.0 PROOF OF PRINCIPLE TREATMENT RECIPE DEVELOPMENT

4.0 TESTING AND DATA RATIONALE

- 4.1 RATIONALE FOR SAMPLING POINTS AND SAMPLING FREQUENCY
- 4.2 IDENTIFICATION OF AND RATIONALE FOR ANALYTICAL METHODS

5.0 PROCESS DESIGN AND TESTING PROCEDURES

- 5.1 DISCUSSION OF DESIGN / CONFIGURATION
  - 5.1.1 DESCRIPTION OF OPERATIONS AND EQUIPMENT
  - 5.1.2 PRE-TREATMENT REQUIREMENTS
  - 5.1.3 TESTING METHODOLOGY
  - 5.1.4 SECONDARY TREATMENT REQUIREMENTS
- 5.2 TEST PROCEDURES
- 5.3 PROCESS CONTROL PLAN
  - 5.3.1 CONTROL LIMITS
  - 5.3.2 OPERATING PARAMETERS/DEVICES/DETECTORS
  - 5.3.3 MONITORING FREQUENCY
- 5.4 TEST LOGS
- 5.5 VIDEO TAPES

6.0 EQUIPMENT AND MATERIALS

Work Plan Outline (continued)

7.0 SAMPLING, DATA COLLECTION AND ANALYSIS PLAN

7.1 SAMPLE POINTS AND DATA REQUIREMENTS

- SAMPLES POINTS AND DATA COLLECTION AROUND ALL UNIT OPERATIONS, INCLUDING PRE-TREATMENT AND POST-TREATMENT, TO SUPPORT MATERIAL BALANCE CALCULATIONS AND DATA NEEDS OUTLINED IN APPENDIX F. SAMPLING SHALL INCLUDE BUT IS NOT LIMITED TO THE FOLLOWING PARAMETERS:

  - CHEMICAL COMPOSITION
  - FLOW RATES
  - TEMPERATURES
  - PRESSURES
  - RETENTION TIMES (WHERE APPLICABLE)
  - ADDITIVES

  SECONDARY WASTE STREAMS

  - CHEMICAL COMPOSITION
  - FLOW RATES
  - TEMPERATURES
  - PRESSURES
  - TSS/TDS (WHERE APPLICABLE)

  TREATED SURROGATE ANALYSIS

  - PER SECTION C.4.2.3.

7.2 SAMPLING LOGS
7.3 SAMPLE CHAIN OF CUSTODY
7.4 ANALYTICAL LABORATORY LOGS
7.5 ANALYTICAL LABORATORY PROCEDURES

8.0 DATA MANAGEMENT PLAN

9.0 DATA ANALYSIS, EVALUATION, AND INTERPRETATION

9.1 MASS AND ENERGY BALANCE - PRIMARY WASTE STREAM
9.2 MASS AND ENERGY BALANCE - SECONDARY WASTE STREAMS
9.3 DATA EVALUATION
9.4 DATA INTERPRETATION

Work Plan Outline (continued)

10.0 HEALTH AND SAFETY REQUIREMENTS FOR PROOF OF PRINCIPLE TESTING ACTIVITIES

11.0 WASTE STREAM MANAGEMENT

- 11.1 REGULATORY ISSUES SPECIFIC TO TESTING FACILITY

12.0 REPORTS

- 12.1 WEEKLY TELECONFERENCES
- 12.2 WEEKLY WRITTEN REPORTS
- 12.3 BI-WEEKLY STATUS MEETINGS
- 12.4 FINAL REPORT (format in Appendix E)

13.0 SCHEDULE

- 12.1 MILESTONES
- 13.2 DURATION
- 13.3 HOLD POINTS
- 13.4 WITNESSING VISITS

14.0 MANAGEMENT AND STAFFING

- 14.1 PROJECT MANAGEMENT
- 14.2 STAFFING
- 14.3 TRAINING

15.0 REGULATORY COMPLIANCE

- 15.1 LICENSES
- 15.2 PERMITS

16.0 REFERENCES

APPENDIX C - Slurry Analyses

Table C1 : Demonstration Surrogate
(Basis: g/100 g dry solids)

a Compound	b mol. wt.	c Composite dry	d Composite insitu	e Chemical %Moisture	f Surrogate Mix
Na2HAsO4	186.01	0.11	0.08	40.38	0.19
BaSO4	233.40	8.97	6.28		8.97
Na2CrO4	161.97	0.20	0.14	30.77	0.29
Fe2O3	159.60	2.77	1.94		2.77
Mg3(PO4)2	262.88	1.92	1.34		1.92
NaNO3	84.99	1.10	0.77	3.00	1.13
NiO	74.71	0.47	0.33		0.47
PbCO3	267.20	13.44	9.41		13.44
PbSO4	303.25	2.91	2.04		2.91
Na2SeO3	173.01	0.07	0.05	34.22	0.11
SiO2 Mix (see below)	60.08	**41.86**	29.30		41.86
V2O5	181.88	0.10	0.07		0.10
ZnO	149.88	0.01	0.01		0.01
Tributyl Phosphate		2.00	1.40		2.00
Kerosene		2.00	1.40		2.00
Diatomaceous Earth		1.99	1.39		1.99
Feldspar - (Na,K)AlSi3O8		20.08	14.06		20.08
H2O	18.00	--	30.00		--
		100.00	100.00	na	100.24

SiO2 Mix		For Above
Course SiO2		21.83
Fine SiO2		10.04
Silica Fume		10.00
	Total	**41.86**

Notes:

Column "c" is the one used in the Surrogate recipe.

Columns "e" and "f" are given only as example. The seller must determine the moisture content of his own chemicals and make the appropriate correction for moisture in Column "e" and determine the actual chemical amounts to be used in the surrogate mix, Column "f".

Table C2 : Silo 1 Surrogate
(Basis: g/100 g dry solids)

a Compound	b mol. wt.	c Silo 1 dry	d Silo 1 insitu	e Chemical %Moisture	f Surrogate Mix
BaSO4	233.40	11.23	7.86		11.23
Na2CrO4	161.97	0.06	0.04	30.77	0.09
Fe2O3	159.60	2.90	2.03		2.90
K2(CO3)2	138.21	0.20	0.14		0.20
MgO	40.31	0.41	0.29	34.22	0.62
MgCO3	84.32	0.73	0.51	8.00	0.79
Mg3(PO4)2	262.88	1.37	0.96		1.37
Na2CO3	105.99	1.28	0.90		1.28
NaNO3	84.99	0.53	0.37	3.00	0.55
NiO	74.71	0.49	0.34		0.49
PbCO3	267.20	16.81	11.77		16.81
PbSO4	303.25	0.00	0.00		0.00
Na2SeO3	173.01	0.09	0.06	34.22	0.14
SiO2 Mix (see below)	60.08	**45.97**	32.18		45.97
V2O5	181.88	0.10	0.07		0.10
ZnO	149.88	0.01	0.01		0.01
Tributyl Phosphate		0.00	0.00		0.00
Kerosene		0.00	0.00		0.00
Diatomaceous Earth		1.60	1.12		1.60
Feldspar - (Na,K)AlSi3O8		16.21	11.35		16.21
H2O	18.00	--	30.00		--
		100.00	100.00	na	100.37

<u>SiO2 Mix</u>		<u>**For Above**</u>
Course SiO2		23.71
Fine SiO2		12.27
Silica Fume		<u>10.00</u>
	Total	**45.97**

Notes:

Column "c" is the one used in the Surrogate recipe.

Columns "e" and "f" are given only as example. The seller must determine the moisture content of his own chemicals and make the appropriate correction for moisture in Column "e" and determine the actual chemical amounts to be used in the surrogate mix, Column "f".

Table C3 : Silo 2 Surrogate
(Basis: g/100 g dry solids)

a	b	c	d	e	f
Compound	mol. wt.	Silo 2 dry	Silo 2 insitu	Chemical %Moisture	Surrogate Mix
Al2O3	101.96	0.89	0.62		0.89
Na2HAsO4	186.01	0.14	0.10	40.38	0.24
BaSO4	233.40	7.40	5.18		7.40
CaCO3	100.09	4.18	2.92		4.18
Na2CrO4	161.97	0.06	0.04	30.77	0.09
Fe2O3	159.60	6.78	4.74		6.78
KNO3	101.11	0.39	0.27		0.39
MgCO3	84.32	2.61	1.83		2.61
Mg3(PO4)2	262.88	1.40	0.98		1.40
Na2CO3	105.99	0.00	0.00		0.00
NaNO3	84.99	0.76	0.53		0.76
NiO	74.71	0.41	0.29		0.41
PbCO3	267.20	4.38	3.06		4.38
PbSO4	303.25	4.38	3.06		4.38
Na2SeO3	173.01	0.07	0.05	34.22	0.11
SiO2 Mix (see below)	60.08	**42.80**	29.96		42.80
V2O5	181.88	0.09	0.06		0.09
ZnO	149.88	0.01	0.01		0.01
Tributyl Phosphate		2.00	1.40		2.00
Kerosene		2.00	1.40		2.00
Diatomaceous Earth		4.82	3.37		4.82
Feldspar - (Na,K)AlSi3O8		14.44	10.11		14.44
H2O	18.00	--	30.00		--
		100.00	100.00	na	100.16

SiO2 Mix		For Above
Course SiO2		23.57
Fine SiO2		9.23
Silica Fume		10.00
	Total	**42.80**

Notes:

Column "c" is the one used in the Surrogate recipe.
Columns "e" and "f" are given only as example. The seller must determine the moisture content of his own chemicals and make the appropriate correction for moisture in Column "e" and determine the actual chemical amounts to be used in the surrogate mix, Column "f".

Surrogate Chemical Requirements

Specifications for the chemicals to make the surrogates are given in Table C4. Chemicals used for the Seller's laboratory studies/formula development shall be the same as used in the demonstration.

Table C4: Compound Specifications

ITEM	REQUIREMENT
Purity of Chemicals	If purchased as "technical grade" or "in bulk," shall be at least 95% pure.
Particle Size of Silica	Shall be 50% at 40-60 micron range, 50%<100 micron range.
Particle Size of all other chemicals	Shall be < 100 micron.
Assays of the bulk material.	Shall be provided 1 week prior to testing. Any impurities greater than 1% shall be identified.
Tolerances	+/- 5%

The formulas for Silo 1, Silo 2, and the demonstration surrogates are presented in Tables C1, C2, and C3, respectively. Prior to the preparation of the surrogates, the Seller shall determine the amount of moisture in each chemical/constituent, except organics. The amount chemical added to the mix shall be increased and the amount of water decreased according. The moisture shall be determined by measuring the weight loss of a known sample of each chemical held for 24 hours in an oven at 105 °C per ASTM Standard D 2216, "Method for Laboratory of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate."

> For example, the recipe calls for 8.00 grams substance y per 100 grams (dry basis) of surrogate used. Also, assume that a 100-gram sample of substance "y"losses 5 grams weight after 24 hours in the oven. Then y's % moisture content is 5 wt% (5/100 × 100 wt% = 5 wt%). The actual amount of substance (adjusted for moisture) to be added to the surrogate is 8.00 grams/(1 - 5/100) = 8.42 grams of substance y per 100 grams of surrogate. Likewise, the amount of water added to the surrogate slurry shall be decreased to 0.42 grams per 100 grams of surrogate slurry (8.42 - 8.00 = 0.42 grams of surrogate).

The tolerance of the surrogate recipes is ±1 wt% relative for those chemicals consisting of more than 0.5 wt% of the recipe and 10 wt% relative for those chemicals consisting of less than 0.5 wt% of the recipe.

For example, 60 grams (per 100 grams of surrogate) of silica are required. The tolerance for silica is 0.6 grams. Therefore, the amount of silica allowed can be between 60.6 grams and 59.4 grams.

Surrogate Mix Validation

The surrogate mixes used by the Seller shall be validated by confirming that the surrogate mixes approximate the behavior of the actual insitu Silo residues. The following parameters are used to define and measure behavior:

- Moisture
- Insitu Density
- Plasticity
- TCLP for Pb

1-kg samples (at 30 wt% moisture) of each of the three surrogate mixes (Silo 1, Silo 2, and Demonstration surrogates) shall be submitted to FDF for verification against the parameters. Limits and means of measuring and adjusting the parameters are as follows:

Moisture

Limit: 30± 2 wt% moisture based on total weight.

Measurement method: The moisture shall be determined by measuring the weight loss of a known sample of each chemical held for 24 hours in an oven at 105 °C per ASTM Standard D 2216, "Method for Laboratory of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate."

Adjustment method: Adding water or drying at between 105 and 110 °C.

Insitu Density

Limit: 1.75 ± 0.10 g/cm^3

Measurement Method: The insitu density shall be determined by packing a known sample mass of sample into a graduated cylinder until no further compaction can be observed.

Adjustment Method: Check particle size and quality of chemicals used. Contact FDF for guidance and resolution.

Plasticity

Limit: Plastic Limit 45 to 55 wt% moisture (dry weight basis).

Measurement Method. Plastic limit determination shall be measured per ASTM Standard, "Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils." The "plastic limit" is the water content, in weight percent based on dry weight, of a soil (or soil-like material) at the boundary between the plastic and brittle (crumbly) states. The water content at this boundary is water content at which a soil can no longer be deformed by rolling 3.2 mm (1/8 in.) diameter threads without crumbling. With more moisture than this limit, the clay will roll into a thread (or a "clay snake"). With less moisture than the limit, the clay will not roll into a thread, but crumble or breaking into pieces.

Adjustment method. Increase the amount of silica fume and decrease the amount of 200-mesh silica in the recipe.

TCLP for Lead

Limit: >800 ppm lead (Pb) leached at a pH 9

Measurement Method: TCLP test.

Adjustment Method: Contact FDF for additional information if required.

Surrogate Slurry – Preparation Specification

The slurries used in the Proof of Principle Testing shall be 30 wt% solids, which is the postulated solids content that can be delivered by a slurry system. This is based on experience gained by the pilot plant at Fernald which operated with simulated slurries. Attempts to operate the pilot plant with solids contents significantly above 30 wt% resulted in delivery problems, e.g., line blockages or failed pumps. Therefore, the slurry for the Proof of Principle Testing shall be based on 30 wt% solids consisting of the following:

Surrogate Recipe	Parts by weight
Solids dry mix simulating Silo Residues	27.6
Dry Bentonite simulating Silo Bentonite Cap	2.4
Water	70.0
Total	100.0

1. In accordance with the above surrogate recipe, add the desired amount of water into a high-speed, high shear mixing tank.

2. Turn on the mix tank. Add the dry mix and the dry bentonite to the mixing tank.

3. Blend at high-speed until the contents are well mixed.

4. Surrogate Slurry Minimum Hold Time

   The surrogate slurries shall be prepared a minimum of 24 hours in advance of treatment by the process or laboratory to allow for complete hydration. Note that the slurry may thicken with time and mixing. This is because the bentonite (and chemicals) hydrating. Also, the absorption of calcium and magnesium ions into the bentonite causes additional thickening.

   FDF has the option of collecting slurry samples for analysis.

5. Slurries for treatment shall be delivered with the tank operating to ensure homogenous mixing and delivery.

6. In accordance with the selected formula, place the dry chemicals into a high-speed, high shear mixing tank.

Treated Surrogate - Properties

1. Waste Loading and Bulking Factor

   Waste (surrogate) loading is to be calculated using the following expression:

$$WasteLoading = \frac{WDW}{WDW + Water + Additives + etc. - DG} x100wt\%$$

Where: Waste Dry Weight (WDW) = Dry Surrogate + Dry Bentonite Weights

DG = Decomposition Gases produced in heat treatment technologies.

In this calculation, water is defined to include the water component of the silos residue, the water added during retrieval and transferring, and the water added during processing. Dry weight is defined as weight of the surrogate (waste) at 105° C.

The bentonite used shall be BentoGrout™. The WDW shall be the weight of the dry surrogate as determined by the formula in Tables C1 through C3.

With thermal processes, the residue will lose weight due to decomposition gasses leaving the surrogates with increasing temperature. These gasses will not become part of the treated surrogate. Therefore, the weight of the decomposition gasses shall be factored in with thermal processes.

2. Bulking Factor

The bulking factor shall be determined by the resulting treated surrogate volume divided by the volume of the 70 wt% solids slurry mixture prepared in step 1 of the procedure. The silos contain approximately 70 wt% solids (30 wt% moisture) insitu. Therefore, the 70 wt% solids slurry mixture made in Step 1 of the procedure shall closely represent the insitu condition in the silos.

$$BF = (V_f \div V_i) \times 100\%$$

Where:

BF = Bulking Factor

V_i = specific volume of the 70 wt% solids slurry mixture prepared in step 1 of the procedure for making surrogate slurries, Appendix C

V_f = specific volume of treated surrogate

APPENDIX D - Quality Assurance Plan Outline

1.0 Management Plan

The QA Plan section shall identify management plans required by the Seller which address organization, functional responsibilities, and level of authority. The QA plan shall address the interfaces for assessing the project.

2.0 Training and Qualification

The QA Plan shall identify the Seller's plan which provides training and qualification requirements for this project. Requirements for assessing training shall be included in the QA Plan.

3.0 Quality Improvement

The QA Plan shall identify the Seller's program requirements for identifying, reporting, tracking, and approving requirements for nonconforming systems, structures and/or components.

4.0 Documents and Records

The QA Plan shall provide requirements for the identification, review, approval, and maintenance of QA records generated for this project. Project verification requirements of record systems shall be covered in this section. This is asking for the contractor to check records and systems before the end of the task to assure that FDF and DOE receives requested records.

5.0 Work Processes

The QA Plan shall identify quality verification requirements for systems, structures and components necessary to provide assurance of process management by the Seller. Seller key work process verifications shall be identified, including those performed by laboratories and sellers.

6.0 Design

The QA Plan shall identify critical design requirements specified in the Seller's design and the method or type of verification needed to assure control and validation of the design.

7.0 Procurement

The QA plan shall identify key procurement which requires verification or oversight by the Seller. Records and methods used to verify Seller performance shall be identified in this section.

8.0 Inspection and Testing

The Seller shall include a list of systems, structures or components and schedule of inspections and tests required for the project. The Seller's plan shall provide for calibration of equipment used for inspections and tests along with evidence of calibration/test.

APPENDIX E - Final Report Outline

The final report shall include the following elements:

1.0 Executive Summary

Includes -Description of the Proof of Principle Testing and results.

2.0 Proof of Principle Test Description

Includes - Test description, project quality assurance, and test objectives and rationale.

3.0 Test Process Design and Procedures

Includes - Sample preparation, additives, formulation, methods for determining optimal formulations, test system description, offgas system description, wastewater treatment system description, equipment and materials to be used, and test procedures.

4.0 Sampling and Analysis

Includes - Characterization of untreated surrogates and methods for analysis used on treated surrogate, wastewater, offgas, and any other secondary waste streams.

5.0 Results and Discussion

Presents leachability and other key data, problems encountered, recommended formulation, waste loading, etc.

6.0 Design Data

The discussion of the full-scale design data shall include an outline strategy/method for developing the design data with a general description of the proposed full-scale design. Discussion shall include the correlation between the data generated by the Proof of Principle Testing and the design data for the Full-Scale Remediation Facility. Tables, graphs, figures, essential to the understanding of the strategy / method and description shall be presented and clearly labeled. Key assumptions shall be identified and justified as well as possible sources of errors.

Technical issues such as waste loadings, sulfate control, and lead and barium leachability, and bulking factors shall be discussed. Items that shall be presented include processability, viscosities, rate of mixing (torque, shear, RPM, bubbling, etc.), measurements unique to the primary process line (i.e. conductivity, for joule heated melters) and robustness. Tables clearly presenting the material and energy balance shall accompany tables listing equipment and specifications (including metallurgy requirements), and process flow diagrams for the primary process line.

7.0 Conclusions

Based on test results provide cost elements as specified. Provide a tentative schedule and design data and information as specified.

Attachments

Telephone conversation logs, Testing Reports, Analytical Data Packages, Sampling Logs, Sample Chain of Custody Forms, Analytical Laboratory Logs.

APPENDIX F - Testing and Data Requirements

EQUIPMENT DATA SHEET	
EQUIPMENT NAME	______________________
EQUIPMENT TAG	______________________
ENGINEER	______________________
SOURCE or SELLER	______________________
CONTACT & PHONE NO	______________________
QUOTE TYPE	(Phone, Catalog, Handbook, Factored, etc.)
PRICE EACH	$
QUANTITY (UNITS)	X
TOTAL COST	$ 0
DIMENSION, SKETCH, OR CATALOG CUT *Information here shall include as a minimum, size, materials of construction and basic equipment specifications	

Table F1: Proof of Principle Process Requirements [1]		
Technical Requirement	**Reason for data**	**Means of reporting requirements**
Process Description	To provide FDF with enough detailed information about the process to allow for an accurate engineering evaluation.	Written text describing the proposed technology. Process Flow Diagram Catalog cuts of major equipment
Mass and Energy Balance a. Pre-treatment b. Process c. Post-treatment	To determine the effectiveness/efficiency of the proposed technology to treat the Silos 1 and 2 residue and to gain a basis for the full scale design analysis.	Mass and energy balance calculations around the system and system components. Parameters shall include as a minimum, temperatures, pressures, concentrations of major constituents, mass or volume flow rates, production rate, etc. Process Flow Diagrams
Processing rate and down-time.	Ensure that the Seller meets the minimum requirements for production rates per section C.4.2.2.	Production rate calculations. Calculations shall include amount of surrogate slurry processed per unit time. A schedule of when the process was in operation and a clear discussion of the cause of any downtime shall also be included (i.e. processing/preparing feed/repairs, etc.).
Secondary waste stream characterization.	To provide FDF with the information necessary to develop secondary waste stream treatment processes.	Sample and analyze the secondary waste streams for the parameters defined in the Sample Plan section of the Work Plan.

[1] The information to be provided to FDF by the Seller includes but is not limited to the items listed in F1. Any information needed to evaluate the categories listed in Table F1 that are unique to a technology shall be provided by the Seller (i.e, viscosity, conductivity, redox state, etc).

Table F2: Full Scale Process Requirements

Technical Requirement	**Reason for data**	**Means of reporting requirements**
Process Description A. Pre-treatment 1. Additives 2. Processing Equipment B. Main Process 1. Additives 2. Processing Equipment C. Post-treatment 1. Additives 2. Processing Equipment D. Secondary Waste Streams 1. Offgas -Expected constituents and quantities 2. Wastewater -Expected constituents and quantities E. Dust Control F. Material Handling 1. Treated Surrogate Form 2. Packaging	To provide FDF with enough detailed information about the full scale process to determine its technological feasibility. To provide FDF with information on any atypical secondary waste stream treatment requirements.	Written text describing the proposed technology in detail. The written text shall include all information requested in the Technical Requirements column. Any information unique to a technology shall also be included in the final report.
Mass and Energy Balance / PFD's A Process System B. Waste Stream Systems C. Utility Systems	To support the evaluation of the full-scale design and determine the ability of the process to meet the Silos 1 and 2 residue handling requirements.	Mass and energy balance calculations around the system and system components. Parameters shall include as a minimum, temperatures, pressures, concentrations of major constituents, mass or volume flow rates, heat exchange, energy usage and production, etc.

Table F2: Full Scale Process Requirements (cont.)		
Technical Requirement	**Reason for data**	**Means of reporting requirements**
General Arrangement Drawings of the Process Area	Provide FDF with a Process Area layout to support a cost analysis of the proposed full scale design	General Arrangement Drawings
Availability Factor	Provide FDF with an estimate of process downtime.	Availability Factor calculation based on Seller experience and documented historical data.
Process Data Sheets for major equipment - Size, Material, Cost etc.	Provide FDF with detailed equipment information to support a cost analysis of the proposed full scale design	Process Data sheets for all major equipment Equipment Spec Sheets: - Equipment Id - Function - Operation - Material Handling - Basic Design Data - Essential Controls - Insulation Requirement - Allowable Tolerances - Special Information (i.e., materials of construction, installation, special design details, supports, etc.)
Cost Estimate A. Plant Cost 1. Major Equipment - Costs 2. Piping, electrical, etc. takeoffs B. Operating Costs 1. Operations 2. Expected Equipment Lifetime (hrs. of operation) 3. Energy Costs 4. Additives	To provide FDF with the necessary information to perform a cost analysis of the proposed full scale design.	Information based on Seller experience and historical data.

Table F3: Proof of Principle Treated Surrogate Requirements [2]		
Technical Requirement	**Reason for data**	**Means of reporting requirements**
TC Limits	To determine if the treated surrogate is effectively treated for RCRA constituents	Provide results of the EPA Toxicity Characteristic Leaching Procedure.
Universal Treatment Standard (UTS)	Provide FDF with a comparison of how the treated surrogate performed against the current TCLP limits versus the UTS limits	Provide results of the TCLP analysis of the treated residue.
Elemental analysis of treated surrogate	Support the mass balance calculations and provide FDF with the assurance that the treated surrogate meets Seller-projected waste loading	Sample and analyze the treated surrogate per the concurred upon sampling plan.
Waste Loading	Provide FDF with the optimum waste loading per Appendix C for dose rate calculations and life cycle cost analysis.	Provide waste loading calculations per Appendix C. Include the data used to perform the calculation.
Bulking Factor	Provide FDF with a basis to calculate a volume estimate of the treated surrogate	Provide bulking factor calculations per Appendix C. Include the data used to perform the calculation.
Treated surrogate does not exhibit RCRA characteristics	Ensure that the treated surrogate is acceptable according to the requirements of Section C.4.2.3.	Evaluate the treated surrogate against requirements of 40CFR 261 Subpart C (261.20 through 261.24)
Compressive Strength by ASTM # C39	Ensure that the treated surrogate meets minimum compressive strength requirements per Section C.4.2.3	Provide compressive strength test results
Treated surrogate is uniform and homogeneous	Ensure that the proposed technology can provide a treated surrogate that is consistent.	Records of visual inspection of treated surrogate are to be recorded by laboratories performing TCLP.

[2] Data provided to FDF shall include but is not limited to the tests outlined in Table F3.

Table F4: Proof of Principle Surrogate Preparation Requirements (Treatment Recipe)		
Technical Requirement	**Reason for data**	**Means of reporting requirements**
Surrogate slurry preparation time prior to testing	To ensure that the bentonite in the surrogate slurry is prepared 24 hours in advance to have time to absorb water.	The Seller shall provide batch sheets.
Purity and mesh size of the bulk chemicals	To ensure the surrogate slurry is consistent with the developed formulas provided by FDF in Appendix C	The Seller shall provide FDF with certification of bulk chemical quality
Homogeneity of the Surrogate Slurry	To ensure the surrogate slurry is consistent.	Visual inspection by FDF personnel and random sampling.
Water content of the Surrogate Slurry	To ensure the surrogate slurry weight percents are in accordance with the formulas provided in Appendix C.	FDF personnel to witness slurry preparation and the Seller shall provide batch sheets.
Elemental Analysis	Independent verification of surrogate slurry elemental make-up	Lab analysis per sampling plan

APPENDIX G - Matrix of Samples for Submittal to FDF

TABLE G1
Sample Geometry and Quantity Requirements for FDF

PROOF OF PROCESS SURROGATE TEST	Purpose of Sample				
	LEACH IMMERSION (Inches)	SHRINKING UNREACTED CORE (Inches)	ARCHIVE (Inches)	ARCHIVE (Inches)	ARCHIVE FINAL FORM SAMPLE (Liters)
Silo 1 surrogate TC (LAB)	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	N/A
Silo 1 surrogate UTS (LAB)	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	N/A
Silo 2 surrogate TC (LAB)	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	N/A
Silo 2 surrogate UTS (LAB)	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	N/A
Demonstration surrogate TC (LAB)	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	N/A
Demonstration surrogate UTS (LAB)	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	N/A
72 hr TC Random1 Demonstration	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	3 \ 1Liter
72 hr TC Random2 Demonstration	6 \1x2 cyl.	6 \ 1x2 cyl.	12 \ 2x2 cube	36\1x2 cyl.	3 \ 1Liter
72 hr TC Random3 Demonstration	6 \1x2 cyl.	6 \1x2 cyl.	12 \2x2 cube	36\1x2 cyl.	3 \ 1Liter

1. Particular attention should be paid to ensuring that the laboratory specimen is homogenous. Specimens should be prepared using the same techniques as those used to produce full-scale waste forms. Curing conditions, especially the temperatures experienced by the large waste forms, should be duplicated for laboratory-scale specimens. Adequate care should be taken to ensure that surfaces of the laboratory specimens reflect the structure of large waste forms.

2. The dimensions, weight, composition and curing history shall be recorded for each specimen. Table G1 shall provide guidance on sampling requirements for samples requested by FDF consistent with sections:
C.4.2.1, Laboratory Scale Development
C.4.2.2 Demonstration of Process.
These samples may be used for independent analysis and/or archiving by FDF at no cost to the Seller.

(End of Section)

SECTION J

LIST OF ATTACHMENTS

ATTACHMENT 1

Fernald Environmental Management Project Approved Laboratory List

Lab Name	Service
CompuChem 3306 Chapel Hill/Nelson Pkwy. Research Triangle Park, NC 27709-4998 POC:	Chemical
DataChem Laboratories 960 West Levoy Drive Salt Lake City, UT 84123 801-266-7700 POC: Jim Johnston	Industrial Hygiene Chemical
Lockheed Martin 975 Kelley Drive Las Vegas, NV 89119-3705 702-361-3955 POC: Mary Ford	Chemical Radiological
General Engineering Laboratory 2040 Savage Road Charleston, SC 29417 803-556-8171 POC: Nancy Slater	Chemical
Recra Environmental, Inc. 208 Welsh Pool Creek Lionville, PA 19341 610-701-6100 POC: Mary Stone	Chemical
Maxim 1908 Innerbelt Business Center St. Louis, MO 63114-5700 314-426-0880 POC: Paul Smith	Chemical Chemical
Pace 5390 McIntyre Street Golden, CO 80403 POC:	Chemical
Quanterra 13715 Rider Trail North Earth City, MO 63045 314-298-8566 POC: Diane Mueller or Robert White	Chemical